

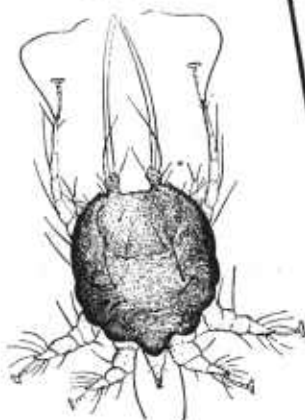
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# SHEEP SCAB

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FARMERS' BULLETIN No. 713  
U. S. DEPARTMENT OF AGRICULTURE

**S**HEEP SCAB is a highly contagious skin disease caused by minute insectlike parasites known as mites. Five different types of scab mites affect sheep, causing five different kinds of scab. These are: Psoroptic or common scab, sarcoptic or head scab, chorioptic scab, demodectic (follicular) scab, and psorergates. The last-named is a newly discovered type and little is now known about treatment of it.

Directions for detecting scab, selecting or making dip, dipping sheep, and building dipping vats are given in this bulletin.

Washington, D. C.

Revised October 1952

# Sheep Scab

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## Varieties and General Characteristics

**S**HEEP SCABIES, commonly known as scab or mange, is a skin disease caused by insect-like parasites known as mites, living on or in the skin. The mites which affect sheep are classified in five different genera, as follows: (1), Psoroptes; (2), Sarcoptes; (3), Chorioptes; (4), Demodex; and (5), Psorergates.

The mites cause wounds or lesions in the skin of the host animal, and as each kind of mite possesses distinctive habits, the nature and especially the location of the lesions indicate the type of mite causing the wounds.

The psoroptic mites, which cause

common scab, live in groups on the surface of the skin and usually produce lesions on the body. The sarcoptic mites burrow into the skin, making galleries in which they live and reproduce. The lesions caused by these mites appear on the head and face, and occasionally on other parts where there is little or no wool. The chorioptic mites live in groups on the surface of the skin, but usually remain localized on the legs. The demodectic mites are truly microscopic in size, smaller than all the other mites, and in appearance are more like worms than true mites. They live in the hair follicles and glands of the skin and cause hard pimples or nodules. The psorergates mites are small and burrow into the skin of the host animal.

<sup>1</sup> Retired.

<sup>2</sup> Revision of former editions by Dr. Marion Imes.

## Psoroptic or Common Scab

Psoroptic or common scab is the most important form of sheep scabies in the United States. It is a highly contagious skin disease, easily transmitted by contact from one sheep to another, and it spreads very rapidly after being introduced into a flock. The disease is not hereditary, but a newborn lamb may become infested from a diseased mother.

When allowed to spread, sheep scab causes great financial loss. These losses result from: (1) A decrease in the quantity of wool, (2) loss in weight and general unthrifty condition, and (3) death of large numbers of infested sheep. The disease is highly contagious, and severe in its effects. However, it is easily cured by proper treatment. A sheep owner should never allow scab to remain in his flock, as it can be easily eradicated by proper dipping.

### Cause of Common Scab

Common scab is caused by small white or yellowish parasites known as *Psoroptes equi* var. *ovis*. The mature female measures about one-fortieth and the male about one-fiftieth of an inch in length. They are visible to the naked eye, especially when they are placed on a dark background. The general form of the body is oval or egg shaped, and the tapering head is longer than it is broad. Mature mites have 8 legs, all of which extend beyond the margin of the body (figs. 1 and 2).

### Symptoms of Common Scab

Scabies mites pierce the skin with their sharp mouth parts to get nourishment. The mites are believed to secrete a poisonous substance into the tiny skin wounds. A bluish-red inflamed area soon surrounds groups of punctures.

Swellings containing pus rapidly develop and rupture. The matter discharged from these swellings and the blood serum from the wounds soon dry, forming thick crusts or scabs on the skin. The disease gets its name from these scabs.

As the mite population increases and seeks the healthier skin, more punctures are made, causing the diseased regions to enlarge. The mites are most active, and can most easily be found, around the outer edge of the scabs.

The mites cause intense irritation and itching. The sheep become restless, scratch, kick, and nibble at the wool with an intensity that is characteristic of this disease. The discomfort is especially noticeable after the animals have been exercised. They bite, scratch, and rub themselves against any object they encounter, including other members of the flock. The wool on affected areas within reach of the animal's mouth frequently becomes moistened with saliva and soiled with dirt. Affected areas that cannot be reached by the mouth usually show a brownish, discolored, and ragged appearance caused by the animal's scratching of the area with its hind feet.

When a diseased area or lesion, is manipulated with the fingers the sheep will turn its head to the affected side, as though to assist in further disturbing the scab. Licking the lips and champing the jaws are characteristic movements of sheep affected with scabies. The fleece early shows a broken disturbed appearance and tags or tufts hang from it that the sheep have pulled out with their mouths or scratched with their hind feet (fig. 3).

The skin soon becomes greatly thickened and wrinkled and, when manipulated with the fingers, frequently cracks and bleeds. The uniformly thickened condition of the diseased skin is readily de-

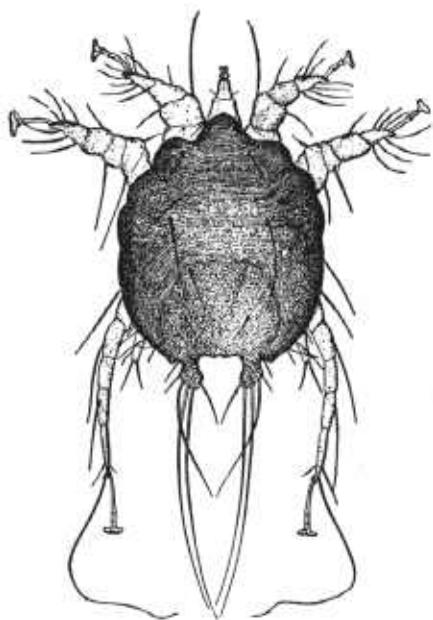
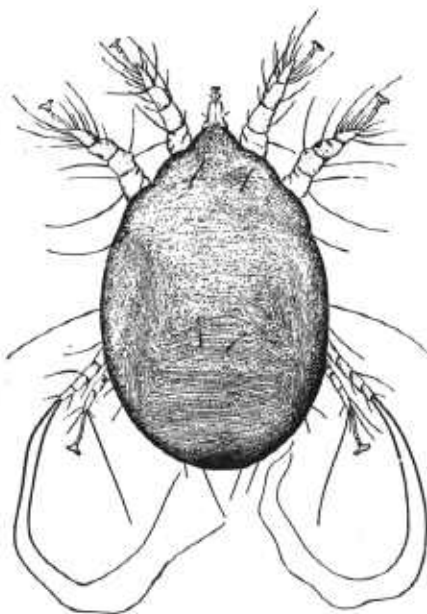
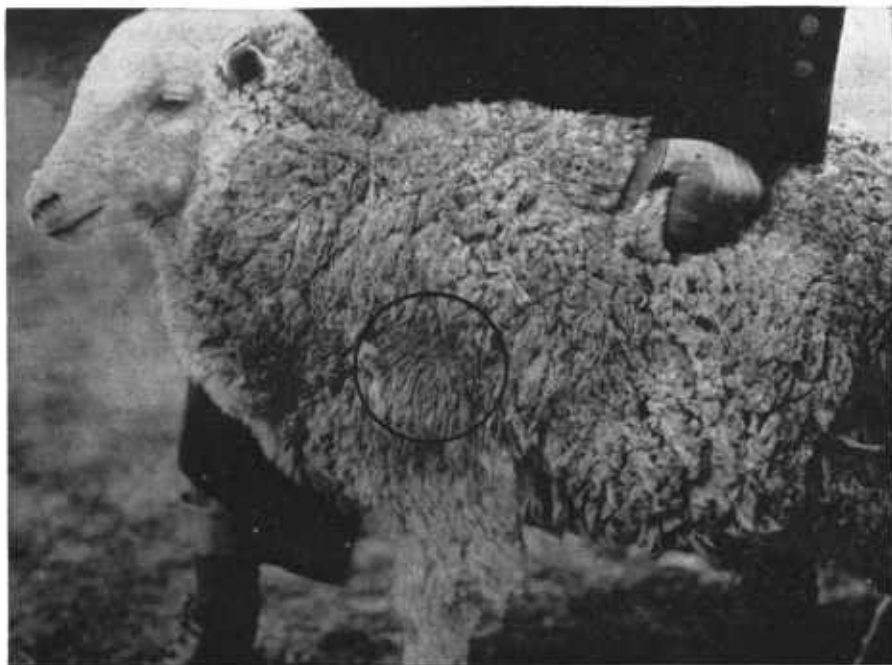


Figure 1.—Sheep scab mite (*Psoroptes equi* var. *ovis*). Male. Dorsal view, greatly enlarged. (After Salmon and Stiles, 1898.)



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Figure 2.—Sheep scab mite (*Psoroptes equi* var. *ovis*). Female. Dorsal view, greatly enlarged. (After Salmon and Stiles, 1898.)



79108-B

Figure 3.—First stage of scab on shoulder, showing natural position of wool disturbed by biting and scratching.

tected by comparing it with the surrounding healthy skin. Other conditions resembling scabies rarely, if ever, cause uniform thickening of the skin.

The chronic diseased areas (lesions) ultimately become hardened and covered with tightly adhering, scaly grayish crusts. This characteristic grayish color results from the accumulation of dried flakes of hardened skin. The wool falls out, leaving bare areas which increase as the disease advances, giving the sheep a naked appearance.

### **Detecting Scab in Early Stages**

The only way to be sure that a sheep has scabies is to actually find scab mites. To obtain specimens of live mites, use one of two methods: (1) Lift the mite from the surface of the skin with the point of a knife blade, or (2) take scrapings of wool and skin containing the mites and isolate the parasites from the scrapings.

To obtain mites with a knife blade good light is necessary. With the forefinger and thumb, suddenly part the wool around the affected areas. With the aid of a magnifying glass or with the naked eye, you may see mites moving rapidly away from the light. These mites may often be picked up on the end of a knife blade.

When the second method of detection is used scrape the outer edges of the infested areas with a blunt-edged knife. Transfer the scrapings to a smooth, black surface, such as a piece of black cloth or a piece of black carbon paper. Spread the scrapings in bright, warm sunlight or near artificial heat and the mites will become active. They can be seen as minute, gray bodies moving against the dark background. They are plainly visible under a low-power hand lens.

It is often difficult to find mites during cold, stormy weather, as

they apparently leave the infested area, where the wool is light, and seek shelter where it is heavier.

Any condition causing the sheep to bite and scratch themselves should be investigated at once (fig. 4). Scab is usually found on the back or sides, but may start on any part of the body. Lambs are sometimes infested on the head between the ears. As this part is frequently covered with dirt, the lesions may not be noticed unless close examination is made. Scab mites are sometimes found in the ears and in the groove above the eyes and in the inguinal pouches. The mites in these places survive imperfect dipping and cause fresh outbreaks after treatment. Scab is often well concealed on wrinkled breeds, especially on bucks, and detection may be difficult. The breasts and bellies of suspected bucks of all breeds should be closely examined, as these parts are frequently affected. Bucks are not so sensitive to the effects of scab as other sheep; consequently they may have scab a long time without showing any symptoms.

Well-advanced cases of chronic scab (fig. 5) are usually easy to diagnose, but the disease should never be allowed to reach the advanced stage, as this means heavy loss to the owner. The experienced sheep grower realizes that common scab, if neglected and allowed to spread, will materially reduce his profits.

### **Contagiousness**

Each species of domesticated animal has its own peculiar species or variety of psoroptic scab. Common sheep scab is not transmissible to other animals, except possibly to goats and cattle. It is highly contagious to all classes of sheep, and is transmitted by direct contact with infested sheep. The mites are unable to breed except on sheep. However, goats and other animals



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Figure 4.—Characteristic scab lesions in early stages of the disease.



9330-B

Figure 5.—A case of scab more advanced than in figure 4, showing area denuded of wool.



herded with them may act as temporary carriers and should be dipped with the sheep.

It is difficult to find out for sure the source of some infestations, especially in range flocks. Frequent sources are public-buck herds and strays. The public-buck herd should always be closely inspected or dipped just before the animals are distributed to the various owners. Infested stray sheep often find their way into clean flocks, and the herders may not know when or where the strays joined them.

Usually clean sheep do not contract scab from infested premises. They may, however, become infested from premises or old bed grounds recently occupied by scabby sheep. Premises which have been vacant for about a month are safe for use by clean sheep. Freshly dipped sheep do not become infested from premises, and flocks may safely be held on such premises between the first and second dipplings. It is good sanitary practice to avoid old bed grounds and uncleaned corrals and premises, but there is practically no danger of scabies infestation from such places after 30 days.

Small inclosures used for sheep should be kept clean, and if they have been occupied by scabby sheep they should be cleaned and disinfected. Remove all litter and manure, cleaning down to a smooth surface, and spray all exposed surfaces with a good insecticide.

The contagiousness of the disease is not limited to any one season of the year. However, during the summer months new infestations are rare. Scab often remains dormant during hot, dry weather and appears to have been cured, but usually becomes evident again with arrival of cold, rainy weather.

The susceptibility of the various breeds to common scab varies somewhat, but as a rule the disease develops more rapidly in fine-wool

sheep than in the loose-wool breeds. Treatment of fine-wool sheep to be successful must be carefully applied, because the grease or yolk in the fleece often prevents penetration of the dip.

Previous attacks of the disease do not result in immunity; a flock may become infested any number of times. As a rule the visible symptoms of reinfestation do not appear for 30 days or more after the last dipping. The dip that remains in the wool often serves for a limited time as a preventive against reinfestation. A dip containing sulfur usually will afford protection for 60 or more days, if the dip is not washed out of the fleece by rain or otherwise. Sheep dipped in BHC have been exposed to infested sheep for as long as 3 months without contracting the disease.

### **Conditions Resembling Common Scab**

Any parasite or condition which results in itching and causes sheep to scratch themselves may be mistaken for scab. A positive diagnosis of scabies cannot be made until the mite is found.

Common sheep scab can be differentiated from conditions caused by other parasites, such as sheep ticks, common ticks, and lice, by finding the mite and by the nature of the lesions. If the itching is caused by ticks, an examination will reveal their presence (fig. 6). Ticks are much larger than scab mites and are dark brown. Lice (figs. 7 and 8) can be easily found on examination. They are much larger than scab mites. Ticks and lice do not, as a rule, produce pronounced local lesions. They move from place to place on the skin, so that scratching and biting are not repeated persistently in one place, as in scab. However, ticks or lice may be found on scabby sheep; finding them does not necessarily

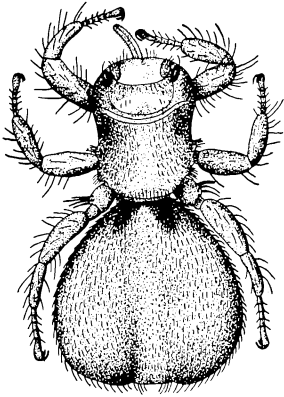


Figure 6.—Sheep tick (*Melophagus ovinus*). Male, dorsal view, enlarged. (From Curtice, 1890.)

mean that scabies is not also present.

Bearded seeds of grass and weeds, thorns and spines from cacti and various other plants often become lodged in the fleece and prick the skin, setting up an irritation which causes the animal to bite and scratch. The wool is pulled out in small tags and the fleece often presents a ragged or broken appearance. Bearded seeds or thorns sometimes penetrate the skin, causing an abscess. On close examination the causative agent can usually be found and removed.

Eczema, wildfire, summer sores, inflammation of the sebaceous

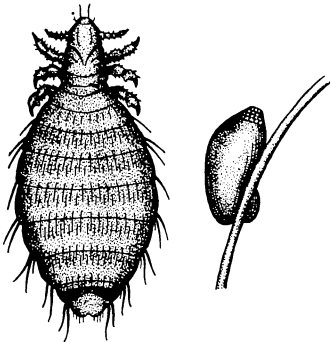


Figure 7.—Sheep foot louse (*Linognathus pedalis*). Adult female and egg, enlarged. (From Osborn, 1896.)

glands, rain rot, shear cuts, sunburn, and the effects of alkali dust on areas denuded of wool may be mistaken for scab.

Eczema, an inflammatory condition of the skin, is usually accompanied by itching and the formation of crusts, and in some cases scabs. It is differentiated from scab in that it does not cause the characteristic thickening of the skin, and the mite is not present.

Wildfire affects sheep mainly in the Northwestern States. It causes the sheep to bite and scratch, thereby breaking the fleece. On exami-

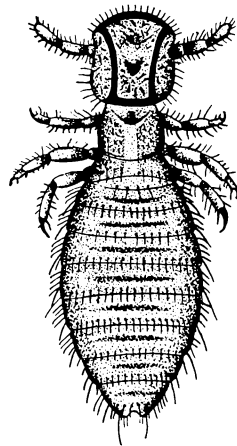


Figure 8.—Sheep louse (*Bovicola ovis*). Adult female, enlarged. (After G. Neumann, 1892.)

nation, the skin is found to be red and inflamed, but soft to the touch. It is not hardened and thickened, as in scab.

A condition commonly known as summer sores exists among sheep in some localities. When this condition is present, the sheep bite and scratch the affected parts until the wool is pulled out and the skin becomes raw and bleeding. It is differentiated from scab by the absence of the scab mite and the fact that the skin is not thickened in the characteristic manner.

Inflammation of the sebaceous glands may be mistaken for scab. There is severe itching, the skin is red and sensitive, and there is an excretion of a strong-smelling, yellowish, viscid yolk. The skin does not have the characteristic appearance of scab and the mite is not present.

In rain rot, a condition occurring in rainy weather, an eruption may appear on the skin which may be mistaken for scab. However, no parasite is present, itching is absent, and the trouble disappears when dry weather comes.

Shear cuts, sunburn, and the effects of alkali on the skin are found in sheep after shearing. They are easily differentiated from common scab by the character of the lesions and the absence of scab mites.

## **Treatments for Common Scab**

The only rational treatment for common scab is to use some external application that will kill the mites. Feeding sulfur and salt and various other preparations to sheep will not destroy mites and consequently will not effect a cure. Hand dressing, commonly called "spot doctoring," consists in soaking the affected parts with warm dip. This tends temporarily to check the disease, but will not effect a cure. When dipping cannot be done because of cold weather or for other reasons, isolation of the visibly affected animals and hand dressing is advisable. All sheep having hard scabs should be separated from the flock just prior to dipping, and these scabs should be soaked well with warm dip and the crusts or scabs broken up by rubbing with a cob or stick.

For many years, the Bureau of Animal Industry has recommended the use of two kinds of dips for sheep scab: (1) Lime-sulfur, and (2) nicotine sulfate. All scabies-infested sheep and those known to

be exposed to the disease and that are to be moved from one State to another, are required to be dipped in one of these dips. If properly used, two dippings in either of these dips, 10 to 12 days apart, can be depended upon to cure cases of common sheep scab. The first dipping kills the mites but does not destroy their eggs. The eggs hatch and form a new generation of mites that must be destroyed by a second dipping before they have had time to lay eggs. Although the proper interval between dippings is 10 to 12 days, the time may be extended to a maximum of 14 days in an emergency.

Since 1940 a new group of chemicals known as the chlorinated hydrocarbon insecticides has been developed for the control and eradication of livestock pests. Benzene hexachloride and lindane, belonging to this group, have been found to be very effective in curing sheep scabies. A single dipping in BHC or lindane destroys the existing mites and the dip material remains insecticidally active in the wool long enough to destroy all the mites hatching after dipping. Tests conducted by wool technologists show that neither BHC nor lindane interfere with the scouring, dyeing, or tensile strength of the fibers. They remain effective in the wool of dipped sheep for a long time. Reinfection of dipped sheep has been prevented for as long as 3 months, in spite of the fact that the treated sheep were constantly exposed to untreated scabby sheep.

BHC and lindane dips are not officially recognized by the United States Bureau of Animal Industry and therefore cannot be used when treatment is performed to comply with Federal regulations governing interstate shipment of sheep.

## **Sarcoptic or Head Scab**

Sarcoptic scab, commonly known as head scab or black muzzle, is

found on sheep in Europe but is not common in the United States. The mite (*Sarcoptes ovis*), which causes the disease, burrows into the skin of the head and face where there is little or no wool. The irritation and itching cause the animal to rub and scratch the affected parts, and the hard scabs which are formed are firmly attached to the underlying skin. This disease may be distinguished from common scab by the nature and location of the lesions and its tendency to remain localized on those parts of the skin that are not covered with wool.

Sarcoptic scab is difficult to eradicate, but can be cured by careful, persistent, and repeated treatments. Thorough soaking of the affected parts with warm lime-and-sulfur dip every 5 or 6 days for a month or 6 weeks is usually effective. Other insecticides have not been tried, because the disease is so infrequent in the United States.

### **Chorioptic Scab**

Chorioptic or symbiotic scab, commonly known as foot scab, is caused by a mite that closely resembles the common scab mite. The parasites live in groups on the surface of the skin, usually on the lower parts of the legs and around the feet, but in severe cases they may spread to the inner surface of the thighs and to the udder and abdomen. The visible lesions usually occur first around the feet and are most pronounced during cold weather, when the flock is housed. The disease is distinguished from common scab by the location of the lesions around the feet and on the legs, and the fact that they do not spread over the body.

The disease is easily cured. Treatment recommended for common scab is effective also against foot scab. Wading tanks filled with dip may be used during cold weather instead of dipping vats.

### **Demodectic (Follicular) Scab**

Demodectic scab, known as follicular mange, is not common in sheep in the United States, but cases have been reported in milk goats. Because milk goats are becoming widely distributed in this country, veterinarians and breeders should be on the lookout for symptoms of the disease.

The mite which causes demodectic mange is not visible to the naked eye. The mites are small and wormlike and infest the hair follicles and sebaceous glands. When present in large numbers they cause swellings or nodules in the skin. The nodules may vary in size from that of a grain of wheat to the size of a walnut. The favorite location in sheep is around the eyelids and in goats on the neck and sides. The hair over the lesion does not usually fall out. For this reason the nodules are not readily visible, but they can be detected by passing the hand lightly over the affected area.

At times the content of the nodules is a thick, cheesy mass, which may be pressed out without lancing. The discharge has the appearance of tooth paste when pressed from the tube. The mass is made up of mites, eggs, and excretions of the skin.

Mature goats appear to be more susceptible than young ones, and the disease spreads slowly by direct contact with infested animals. No reliable method of treatment is known. Infested animals may be treated by opening all the nodules, removing the contents, and irrigating the pockets with a 2-percent solution of coal-tar-creosote dip. Some investigators report good results with the use of a few drops of a saturated solution of carbolic acid in each pocket. After the undissolved acid has settled to the bottom of the container the upper part of the solution may be

poured off and used in the same way as the coal-tar-cresote dip.

Infested animals should be removed from the flock and treated or destroyed, and as a precautionary measure the flock should be dipped several times in coal-tar-cresote dip.

## **Psorergates**

In 1941 Carter in Australia described a form of sheep scab affecting fine-wooled Merino sheep and caused by a mite previously found only in mice and voles. In 1951 this mite was found on sheep in Ohio. It causes a mild irritation and itchiness in sheep similar to that caused by lice. The sheep bite and scratch the affected areas most easily reached, such as the sides, flanks, and rump. Tags of wool are pulled out, and the fleece has a ragged, tangled appearance. The tips of the wool fibers are twisted or curled into locks, matted, and hang loosely from the sides.

The mite causing the disease is approximately one-third the size of the common sheep scab mite. The head is short and broad. The general form of the body is rounded and more narrow than long. Eight short stubby legs extend from the sides of the body and are placed at equal distances from one another. A double hook is found at the end of each leg. The mite burrows into the skin causing a slight thickening, roughening, and scaling of the affected area. The scales are usually loose, dry, and crumbly, and occasional moist spots are found in the lesions.

Because of the mite's small size and burrowing habits, it is very difficult to find. It is necessary to make deep skin scrapings with a scalpel or pocket knife and to examine the material in light mineral oil under a microscope in order to find the mites.

Very little is as yet known about its life history or the proper method

of treatment. The infestation spreads very slowly and may require 3 or 4 years' time to become generalized on a sheep. The intensity of an infestation may vary from year to year. Some animals appear to recover, but usually there is a recurrence from time to time.

## **Dipping Sheep**

Dipping in a medicated solution that will kill the parasites is the only practical method known for eradicating scabies in sheep. The sheep enter one end of a vat filled with dip, swim through, and leave at the opposite end.

Lime-sulfur or nicotine sulfate dips are used warm in order to penetrate the fleece and the hard scabs or crusts. Two or more dippings are necessary to effect a cure. When benzene hexachloride (BHC) or lindane is used, the dip need not be heated and a single dipping, properly performed, will cure scab.

If only sheep showing scab are dipped, the disease will continue to develop in the undipped portion of the flock. Dip all the sheep in the flock.

For dipping purposes soft water is better than hard. Some of the ready-prepared dips do not mix properly and are not effective with hard water. If hard or alkali water must be used its effects can be increased if it is softened by adding lye or sal soda, but no more should be added than is required to cut the water. An excess of potash tends to injure the wool and to cause irritation of the eyes. The effectiveness of the dip can be increased by the addition of a common household detergent, which decreases the surface tension of the water and results in greater penetration of the wool. From  $\frac{1}{2}$  to 1 pound of detergent per 100 gallons of water is recommended.

## **Estimating Amount of Dip Needed**

The quantity of dip in the vat should be sufficient to submerge the sheep completely. The depth of the dipping fluid should be from 40 to 48 inches, depending on the size of the sheep. First, ascertain the quantity of fluid necessary to fill the vat to the required depth.

Freshly shorn sheep and short-wooled lambs will carry out an average of 1 to 2 quarts of dip, depending on their size and the length and grade of wool. A full-fleeced, fine-wool sheep will carry out and retain in the fleece as much as 2 gallons. During late fall dipping, the average medium-wool sheep will retain about 1 gallon of dip.

After computing the dip required to fill the vat to dipping level, estimate the average quantity of dip each sheep will carry out; multiply this by the number of sheep to be dipped. Add this amount to that required to first fill the vat. If the vat and draining pens are watertight, so that no dip leaks out, the result of this computation will be the approximate number of gallons of dip required to complete the work.

## **Directions for Dipping**

To insure success in dipping, pay close attention to details and see that the work is carefully and thoroughly performed. Do not dip sheep for at least 10 days after shearing so that all shear cuts may have time to heal. It is dangerous to dip sheep with fresh wounds in lime-sulfur; for this reason dogs that bite should not be allowed in the dipping corrals. Examine the chutes, pens, and dipping vat closely for nails, broken boards, or any object that may puncture or wound the sheep. Dipping wounds in lime-sulfur may cause a condition commonly known as "blood

poisoning," from which the mortality is high. After the wounds have granulated or healing is well started there is little or no danger from dipping. Rough handling of sheep during dipping results in much damage to the flock. The men handling them should be instructed to do so carefully. They should not be allowed to catch sheep by the ears. This results in breaking or bruising of the skin, which causes the heads to swell after dipping, and considerable death loss.

Dip bucks separately from ewes and lambs. They drown very easily in the vat. Give them careful attention. If they have been driven to the vat, they should not be dipped until they have rested and cooled off. Hard scab on rams is difficult to cure, and they should be held in the swim from 3 to 5 minutes. Manipulate the hard scabs so that the dip may penetrate to every part. At large vats the bucks are usually dipped first, while the vat is full, so as to afford more swimming room.

Ewes and lambs should not be dipped together. The lambs should be "cut out" and dipped separately, because they need not be held in the swim as long as older sheep. When ewes and lambs are put into the vat together, there is danger of drowning some of the lambs. It has been stated that the ewe recognizes her lamb more readily when they are dipped together; this, however, is probably not correct. A ewe recognizes her lamb by smell and not by sight; consequently after the flock has been dipped and the ewes and lambs have been turned in together there is considerable commotion for a time, as the ewes fail temporarily to recognize their offspring. However, the members of the flock will adjust matters for themselves, and as a rule practically every lamb will be recognized by its mother.

Sometimes an undipped sheep will jump out of the pen and get in



Figure 9.—Dipping sheep in a concrete vat, showing entrance. Note sharp slant of the slide board.

with those that have been dipped. Be sure to dip all such sheep before the flock leaves the vat. Look the dipped sheep over carefully to detect any undipped ones.

Sheep should not be thirsty or hungry at the time of dipping, nor too full of feed and water. If watered and fed from 3 to 6 hours before dipping they will be in the best condition for the operation.

When the weather is cold or stormy, begin dipping operations early in order to finish by noon so that the last sheep dipped will dry off before night. A sheep with a full stomach will withstand much cold and hardship. If these precautions are observed, sheep may be dipped with reasonable safety during cold weather.

Immediately after adding the in-



9333-B

Figure 10.—Dipping sheep in a wooden vat, showing exit. The sheep are coming up out of the dip and up to the crawling board.

secticide stir the contents of the vat thoroughly. Stirring maintains powdered insecticides in suspension and produces a more uniform temperature throughout in dips that are heated. In large vats, the dip can be stirred with a bucket attached to a rope. Allow it to fill and partially sink; then drag it rapidly from one end of the vat to the other. Repeat the process until the temperature is the same at several points in the vat.

Stirring plungers (fig. 11) are useful implements. They are easily made, and one or more should be provided at every vat. The plunger is pushed to the bottom of the vat and raised rapidly, the process being repeated as the operator moves slowly along the vat.

Change the dip as soon as it becomes filthy, regardless of the number of sheep that have been dipped in it. BHC and lindane as well as lime-sulfur and nicotine do not kill bacteria nor inhibit their growth. Filth introduced into the vat carries several kinds of bacteria that may produce infection. Some of the harmful bacteria are gas-producing organisms. When gas bubbles rise from the bottom of the vat, or when the dip turns dark or blackish color, it is usually a sign of contamination. When this occurs, change the vat contents.

Under favorable conditions, up to 3,000 sheep may be dipped in BHC or lindane in a 1,000-gallon vat—without changing the entire contents. The contents of a dipping vat of this size can be maintained effective for scabies eradication by replenishing it in the proper proportions each time as much as 200 gallons are carried out in the wool of the dipped sheep.

Determine the temperature of the dip accurately with a thermometer. If it is too high the sheep may be injured, and if too low failure to cure will probably result. In field operations, when lime-sulfur and nicotine sulfate dips are used under

the supervision of inspectors, the temperature of the dip should be maintained at 100° to 105° F. The coal-tar-creosote and cresylic-acid dips should be used at slightly lower temperatures, the maximum being 95° F. BHC and lindane dips should be used unheated. In very cold weather when it is desirable to remove the chill, these dips may be warmed but never to more than 80° F.

For use in dipping small lots of farm sheep an ordinary dairy ther-

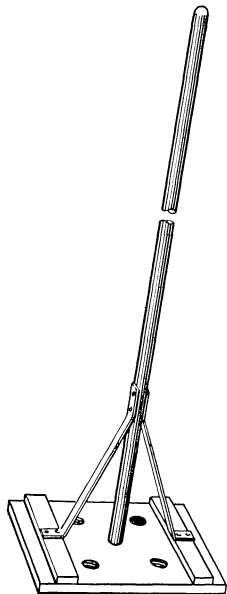


Figure 11.—Stirring plunger for mixing liquids in the vat.

mometer will be adequate to measure temperature. At a large vat, where a great many sheep are to be dipped, provide at least two thermometers as a precaution against breakage and delay. Test the accuracy of each thermometer occasionally by comparison with another thermometer.

To change vat contents first dip out or drain off the liquid, then remove all the dirt at the bottom with a hoe or spade. Lime-sulfur dip should not be used again after



it is 10 days old. This is a safe rule to follow with all dips, to avoid losses from dipping in old or stale dips.

When lime-sulfur or nicotine sulfate is used, always hold sheep in the dip at least 2 minutes. If the scab is not advanced, from 2 to 3 minutes in the vat is sufficient; but in well-advanced cases of hard scab on fine-wool sheep, especially bucks, better results are obtained if they are held in the vat from 3 to 5 minutes during the first dipping. In all cases in which the disease is advanced, break up the hard scabs by hand and soak the affected parts thoroughly with dip from a bucket before the animals are put into the vat. In hand dressing such spots, take care not to cause bleeding, as the blood will tend to protect the mites from the effect of the dip. After hand dressing, allow at least 1 hour for the scabs to become soaked before placing the sheep in the vat.

When BHC or lindane is used, this precaution is not necessary because they have been found to cure the most advanced cases of scabies with a single dipping, and 1 minute in the vat is usually sufficient.

Do not guess the length of time the sheep are in the vat. Use a watch or a 2-minute sand glass to make certain that the animals remain in the dip for a sufficient length of time. Where a large vat is used and the sheep are running fairly well it is possible, after a little practice, to arrive at an average working rule as to how many sheep are to pass through the holding gate each time it is raised.

Drowning sheep in the vat can be avoided by proper care. Men with dipping forks should be stationed along the vat on both sides to attend to the sheep and prevent accidents.

When the vat becomes filled with sheep their progress is retarded, and the tendency is for each sheep to place its front feet

on the back of the sheep in front and thus raise its forequarters out of the dip. The men along the vat should prevent this by keeping the sheep properly arranged in the vat. The dipping forks should be used to keep the sheep's bodies submerged; their heads should be submerged for an instant at least twice. This can be done by placing the dipping fork over the shoulders of the sheep and gently but firmly pushing them under. The animals will raise their noses so that the necks and part of the heads can be submerged without danger of strangling.

Old ewes that have been dipped a number of times are sometimes difficult to handle, both in the chutes and in the dip. They will often lie on their sides in the vat, bracing themselves with their feet against one side and their backs against the other. When pushed under they make efforts to regain this position and may strangle. Sheep that are affected by eating loco weed often drown in the vat unless they are piloted through.

When a sheep strangles, take it from the vat. If it does not get to its feet, pull the tongue forward, dash cold water over the head and body, and, if necessary, induce artificial respiration. If it had not been in the dip long enough, give it time to regain its strength, and then pilot it through the vat again.

## Dipping Forks

In large vats dipping forks are necessary for the efficient handling of sheep and should be provided as part of the equipment at every plant. A number of different styles are made, but the two shown (fig. 12) are the ones commonly used. The one with both hooks turned the same way seems to have the preference, because either side may be hooked under the neck of the sheep to raise the head in case of strangling. The handles

should be strong and from 5 to 6 feet long. The hooks should be made of half-inch round iron with blunt ends and firmly held in the handle by an iron ferrule. These forks can be bought ready-made or may be made by a blacksmith.

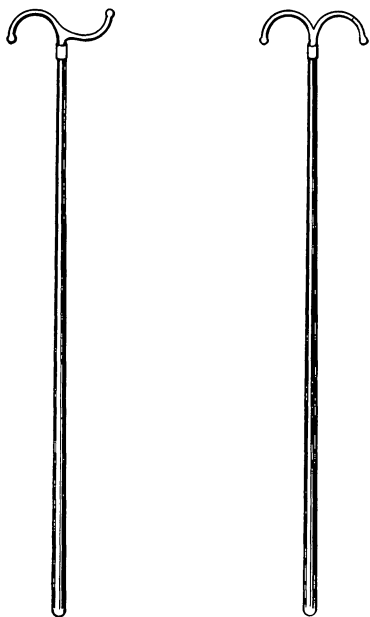


Figure 12.—Two styles of dipping forks

## Dips

The dips on the market today can be divided into six general groups—those containing arsenic, the cresylic-acid group, coal-tar-cresosote, nicotine, lime-sulfur, and the chlorinated hydrocarbons such as BHC and lindane. The Bureau of Animal Industry recognizes only two groups for official dipping of sheep for scabies, namely lime-sulfur and nicotine.

Dips deteriorate from use; after a number of sheep pass through the vat the active principle of the dip falls below the standard required for effective work. Chemical testing outfits are necessary to determine the percentage of the active principle in the dip at any time. In this way the strength

can be kept up to the required standard. Before a dip is approved for official dipping of sheep, the Bureau of Animal Industry requires that a practical field test be made with it. At present lime-sulfur and nicotine dips are the only ones for which practical field tests have been devised.

There are many dipping preparations on the market. Do not be deceived by exaggerated statements made by manufacturers. The nature of the dip and its effects on sheep when used in the kind of water available should be known. A dip that will kill the parasites and not cause undue injury to the sheep should be selected. Almost all of the better-known, ready-prepared dips will be satisfactory if used according to directions and with pure water. If the dipping plant is not supplied with pure, soft water, select a dip that will work well in the kind of water available. Lime-sulfur, BHC, and lindane mix properly and are effective with almost any kind of water. The coal-tar-cresosote and cresylic-acid dips do not mix uniformly with some hard waters, and should not be used with such waters.

Whatever dip is selected, be sure to use it according to directions. Attempts to economize in time, labor, or money by using weaker proportions, by hurrying the sheep through, or by failing to dip all the sheep, result in failure. If they are used according to directions, any of the established dips should result in a cure. Desired results can be accomplished only by performing every part of the work thoroughly and with approved methods.

## Ready-Made Products

Until the advent of chlorinated hydrocarbon insecticides, lime-sulfur and nicotine were the dips commonly used in the United States for dipping sheep infested with scabies. Nicotine dips are sold

under various trade names, and the percentage of nicotine in the product, as well as specific instructions for diluting the dip, should be given on the container.

Proprietary brands of liquid lime-and-sulfur may be purchased. Many of these are equal to or even better than the home-made product. Manufacturers have also placed on the market a product commonly known as dry lime-sulfur, made by evaporating in a vacuum or in the presence of an inert gas, concentrated lime-sulfur solution to which a little cane sugar has been added to act as a stabilizing agent. The insecticidal constituents of dry lime-sulfur are readily soluble in hot water, and it is extensively used as a dip for animals and as an insecticide for plants. Dilute all ready-prepared dips and use according to instructions on the container.

Benzene hexachloride and lindane can be obtained as wettable powders or emulsion concentrates. The active insecticidal agent in these substances is known as the gamma isomer. Wettable BHC is produced commercially containing a gamma isomer content of 6, 10, or 12 percent. Lindane is produced containing 25 percent of gamma isomer. Only the wettable powders are recommended for sheep scabies.

## Home-Made Lime-Sulfur Dip

Lime-sulfur dip is made in the proportion of 8 pounds of unslaked lime (or 11 pounds of commercial hydrated lime, not air-slaked) and 24 pounds of flowers of sulfur to 100 gallons of water.

Place the lime in a watertight shallow box, and add enough water to form a thin paste. Sift the sulfur into it and mix well until a paste having the consistency of mortar is formed, adding water as required.

Place the lime-sulfur paste in 30 gallons of boiling water and boil for at least 2 hours, adding water from

time to time to maintain the quantity at approximately 30 gallons. During the boiling process stir the mixture in the boiling tank well to prevent the paste from settling and caking on the bottom. A large mortar hoe is a good implement with which to stir the boiling mixture. Continue boiling until all the sulfur disappears from the surface. After the mixture has been boiled for 2 hours the liquid should be a chocolate or dark-amber color.

Weigh both the lime and sulfur; do not guess at the weight. Sometimes the sulfur is not all "cut" or dissolved; especially if the lime is not of first quality. Sometimes an experienced person will add small quantities of extra lime if the sulfur is not being "cut" properly. It is advisable, however, for the beginner to hold strictly to the formula laid down, as an excess of lime will tend to injure the sheep and wool.

Draw off or dip out the contents of the boiling tank and place in the settling tank, and allow to stand until all sediment has settled to the bottom and the liquid is clear. It is necessary to use some sort of settling tank provided with a bunghole unless the boiler is so arranged that it may be used for both boiling and settling. An ordinary watertight barrel will answer very well for a settling tank at small vats. All settling tanks should have an outlet at least 4 inches from the bottom, in order that the clear liquid may be drawn off without becoming mixed with any of the sediment (fig. 13). Drawing off the liquid does not stir up the sediment as dipping does.

Keep the liquid clear and free of sediment. Dip with sediment in it injures the wool and eyes of sheep.

When the mixture is fully settled, draw off the clear liquid into the dipping vat and add sufficient warm water to make a total of 100 gallons of dip. When mixed and cooked as specified the concentrate is  $3\frac{1}{2}$  times the strength

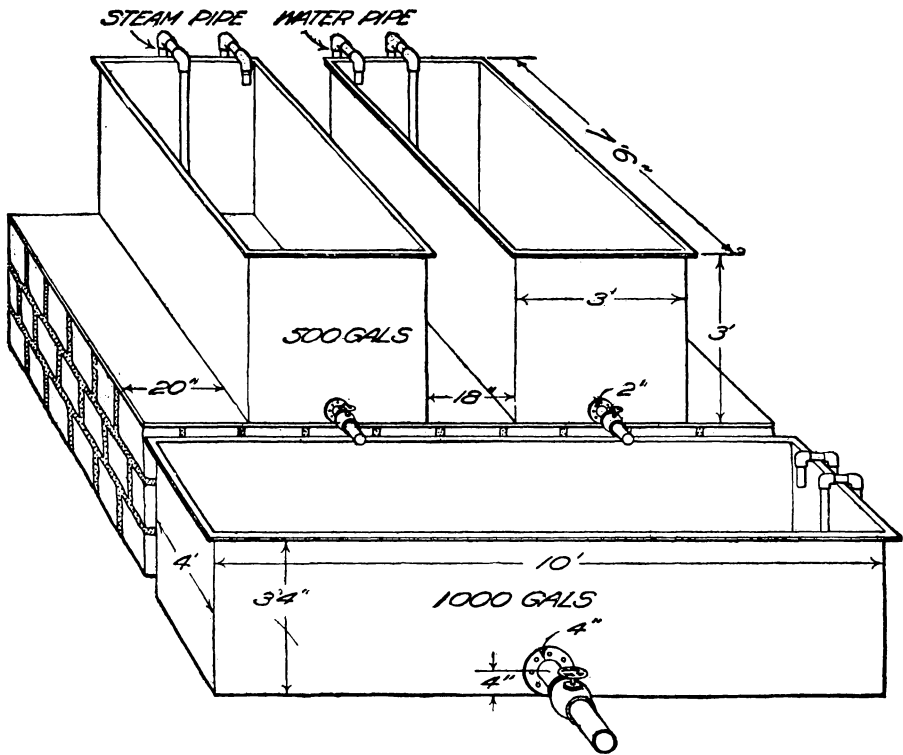


Figure 13.—Cooking and settling tanks.

required for the dip in the vat; hence, to make a dip of the required strength, 70 gallons of warm water should be added to every 30 gallons of concentrate.

In preparing lime-sulfur dip in large quantities several hundred gallons of concentrate are often made at one time in a single large cooking tank. The quantity made at one boiling is limited only by the facilities at hand. If the boiling tank is of sufficient capacity, make enough lime-sulfur paste at one time to dip the flock. The quantity of mixture in the cooking tank may be varied at will, but the proportions of the various ingredients should not be altered.

### Nicotine Dip

Nicotine dip is made with sufficient nicotine solution to produce a mixture containing not less than

five one-hundredths of 1 percent (0.05 percent) nicotine. Sufficient nicotine for 96 gallons (about 800 pounds) of dip would therefore be furnished by 1 pound of a 40-percent solution of nicotine. The formula for this dip is: Nicotine, 0.4 pound; water, 96 gallons.

To calculate the quantity of nicotine solution to be used for 96 gallons of water, divide the quantity of nicotine required in the dip by the proportion of nicotine in the product. For example, suppose the nicotine solution contains 25 percent nicotine, the computation would be  $0.4 \div 0.25 = 1.6$ . In this case, therefore, 1.6 pounds of nicotine solution would be required for 96 gallons of dip. Do not use a product if the percentage of nicotine is not stated.

Never heat nicotine dip above 105° F., as heat will evaporate the nicotine and weaken the dip.

# Chlorinated Hydrocarbon Dips

The two chlorinated hydrocarbon dips most commonly used for sheep scabies are BHC and lindane. BHC has been used extensively throughout the United States and reports from all sections show it to be very effective against the most acute and chronic cases of this disease. Owing to its remarkable effectiveness and its ability to eradicate scabies at a single dipping, it is frequently preferred over older dips, such as lime-sulfur and nicotine-sulfate. Remember that although BHC has been found entirely reliable for the control and eradication of sheep scabies, the Bureau of Animal Industry requires that lime-sulfur and nicotine-sulfate be used in official treatment of sheep destined for interstate shipment. This requirement is based on the necessity of having an accurate and suitable test by which the concentration of the dip can be determined at all times during the dipping process. No such test exists now for BHC or lindane.

BHC can be purchased as wettable powder. The insecticidal agent in the powder is the gamma isomer, and the quantity used with water to fill the vat is based upon the percent of gamma isomer in the powder. It is, therefore, necessary to note the gamma isomer content of the BHC purchased. It is usually produced with a gamma isomer content of 6, 10, or 12 percent.

Lindane is as effective against sheep scabies as BHC, but it is more expensive. The gamma isomer content of lindane as obtained commercially is 25 percent. It is used for the treatment of sheep scabies in the same concentration as BHC.

The recommended concentration of gamma isomer in the dip for treating sheep scabies with BHC or lindane is 0.06 percent. Table 1 gives the quantities of BHC and

TABLE 1. *Recommended concentrations of BHC and lindane powders of varying percentages of gamma isomer for an 0.06-percent dip for sheep scabies*

Powder	Gamma isomer of powder	Quantity of powder required per 100 gallons of water to—	
		Fill vat initially	Replenish vat
	Percent	Pounds	Pounds
BHC-----	6	8 <sup>3</sup> / <sub>8</sub>	9
BHC-----	10	5	5 <sup>1</sup> / <sub>2</sub>
BHC-----	12	4 <sup>1</sup> / <sub>4</sub>	4 <sup>1</sup> / <sub>2</sub>
Lindane-----	25	2	2 <sup>1</sup> / <sub>4</sub>

lindane powder per 100 gallons of water necessary to make and to maintain a dip containing 0.06 percent gamma isomer.

To mix the dip, fill the vat with water and add the powder. In very cold weather the dip may be warmed to take off the chill, but in no case should it be heated to more than 80° F. As each sheep goes through the vat it removes a quantity of water as well as of insecticide. In addition to knowing the quantity of powder required for dip to fill the vat initially, it is necessary to know how much powder to add to replace the quantity removed by the dipped sheep.

Before the sheep are put into the vat, stir the contents thoroughly, because BHC and lindane powder settle rapidly to the bottom. During dipping, the movements of the sheep keep the dip adequately stirred, but as soon as they leave, the powder settles to the bottom. Stir after each delay in operation.

BHC and lindane, like other dips, do not kill bacteria, and the same precautions in regard to wounds and abrasions apply with them also.

## Injury From Dipping

Dipping often results in a slight setback to sheep. There may be

a temporary shrinkage in weight, constitutional disturbances, or both. Such setbacks may occur with any of the standard dips, but should not always be attributed to the effects of the dip alone. The age and physical condition of the sheep, the method of handling at the vat as well as before and after dipping, the kind of water used, the method of preparing the dip, and various other factors should be given consideration before placing the blame on the dip.

Young animals in a thriving condition recuperate rapidly from any temporary ill effects, but old, weak, or emaciated animals may succumb very readily to the toxic effects of the dips. If they survive, they regain lost weight slowly.

Injury caused by dipping is more likely to result from improper methods of dipping and handling than from the direct effects of the dip. Rough handling in the corral and catch pens, dipping immediately after a long, hard drive before they have rested and cooled off, dipping late in the afternoon when the nights are cold, keeping the sheep without feed and water for long periods before and after dipping, using dogs in the corral, and fighting stubborn sheep to get them into the chutes, are some of the contributing causes of injury.

Much of the water in the range country carries various quantities of mineral salts, and is commonly known as "alkali" water. Some insecticides do not mix properly with many of these waters, and a separation occurs, so that part of the sheep get too much of the active principle with resultant injury or death, while others get less than is required to kill the parasites. Lime-sulfur, BHC, lindane, and nicotine dips are about the only ones that are safe to use with very impure water. Any of the dips are injurious if they are used too strong.

Lime-sulfur and possibly other dips cause serious injury to sheep

with puncture wounds. A condition commonly known as "blood poisoning" is produced. The wound is seared and at times sealed by the action of the dip. Air is excluded from the wound and drainage stops, creating conditions favorable to the development of pathogenic bacteria. Pure lime-sulfur solution will not injure a sterile wound. The dip does not directly cause the "blood poisoning," but acts only as a contributing cause, and can be avoided by allowing wounds to granulate or heal before dipping. Experience has demonstrated that when sheep are properly dipped in any of the approved dips in accordance with the rules of best practice, the loss of or damage to animals is negligible.

The question often arises as to what is the proper age at which lambs should be dipped to get the best results and to insure the least injury or loss. When the average lamb in a flock is 1 month old it is perfectly safe to dip the flock, provided the lambs are dipped separately. Any slight shrinkage caused at this time will be quickly regained, and the lambs will grow and thrive much more rapidly after being freed of the irritation caused by the scab mites. If the work is properly done and the sheep are carefully handled, pregnant ewes may be dipped any time up to within 1 month of lambing.

There has been much controversy concerning the effects of various dips on wool. The general opinion is that the well-known dips properly prepared and used injure the wool very little, if any. Tests by wool technologists on samples of wool from sheep dipped in BHC have proved that the tensile strength and dyeing properties are in no way affected by this insecticide. It is necessary to eradicate scab to make wool growing profitable, or even possible. Lime-sulfur and nicotine are among the dips that have been effective and

have been generally used as scab eradicators, both in this and in other sheep-growing countries. Any slight damage they may do to the wool is more than offset by their good effects in eradicating scab.

## Dipping Plants and Vats

Numerous kinds of dipping plants are in use, the size and style varying according to the conditions to be met and the individual tastes of the owner. The farmer who has only a small flock can use a small portable vat (fig. 14), turning a part of his barnyard or sheds into catch pens for temporary use, but if he is in the sheep business to stay he will find it advisable to make more permanent arrangements. Portable galvanized-iron dipping vats, called "hog vats," can be purchased ready-made and will do very well for dipping small lots of sheep.

When large flocks are to be dipped, a permanent dipping plant is the only practical solution.

## Selecting a Location

Place the dipping plant on ground that has good drainage. The vat itself should be on level ground, its entrance facing south, its exit north. Sheep work better when not facing the sun. They also work better when they are driven upgrade. Therefore, plan to have the receiving pens and chutes slope up to the vat.

## Selecting Type of Dipping Plant

The plans for the construction of concrete and wooden sheep-dipping plants (figs. 15 and 16) are not drawn to a uniform scale; consequently, in studying the drawings, note the scale of each part. The plants shown have no superfluous equipment, and the operating arrangements are designed to insure maximum efficiency. The size can be increased or decreased as desired. A different corral, chute, and catch pen arrangement is shown with each vat. All parts are interchangeable and are suitable for use with either vat. Cross fences can be added to the corrals as desired. Cutting chutes are shown in both plans. Every large dipping plant should have a chute equipped with a dodge gate, so that the lambs may be cut out and dipped separately.

If permanent pipes are used to conduct water and dip to the vat they should not obstruct the path along either side of the vat. A portable V-shaped trough can be used to conduct liquids into the vat and may be laid aside when it is not in use.

## Corrals and Chutes

The arrangement of corrals is important. Poorly arranged corrals cause much damage to sheep that may wrongly be attributed to the preparation in which they were dipped. The receiving corral, as well as the holding corral into which they go from the draining pens,

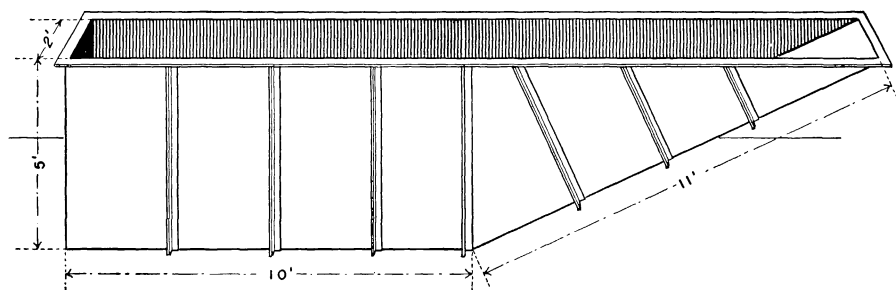


Figure 14.—Portable galvanized-iron sheep-dipping vat.

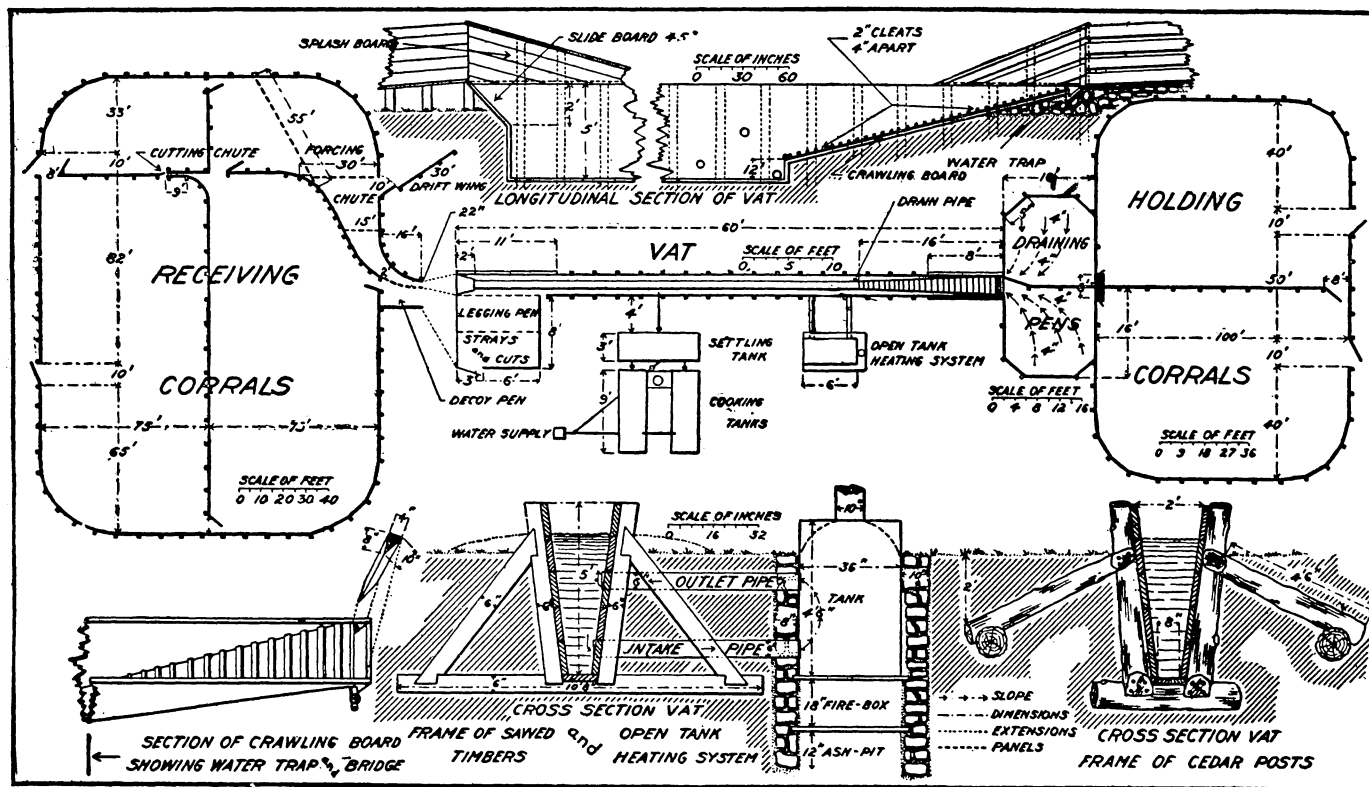


Figure 15.—Plan of sheep-dipping plant; wooden vat.



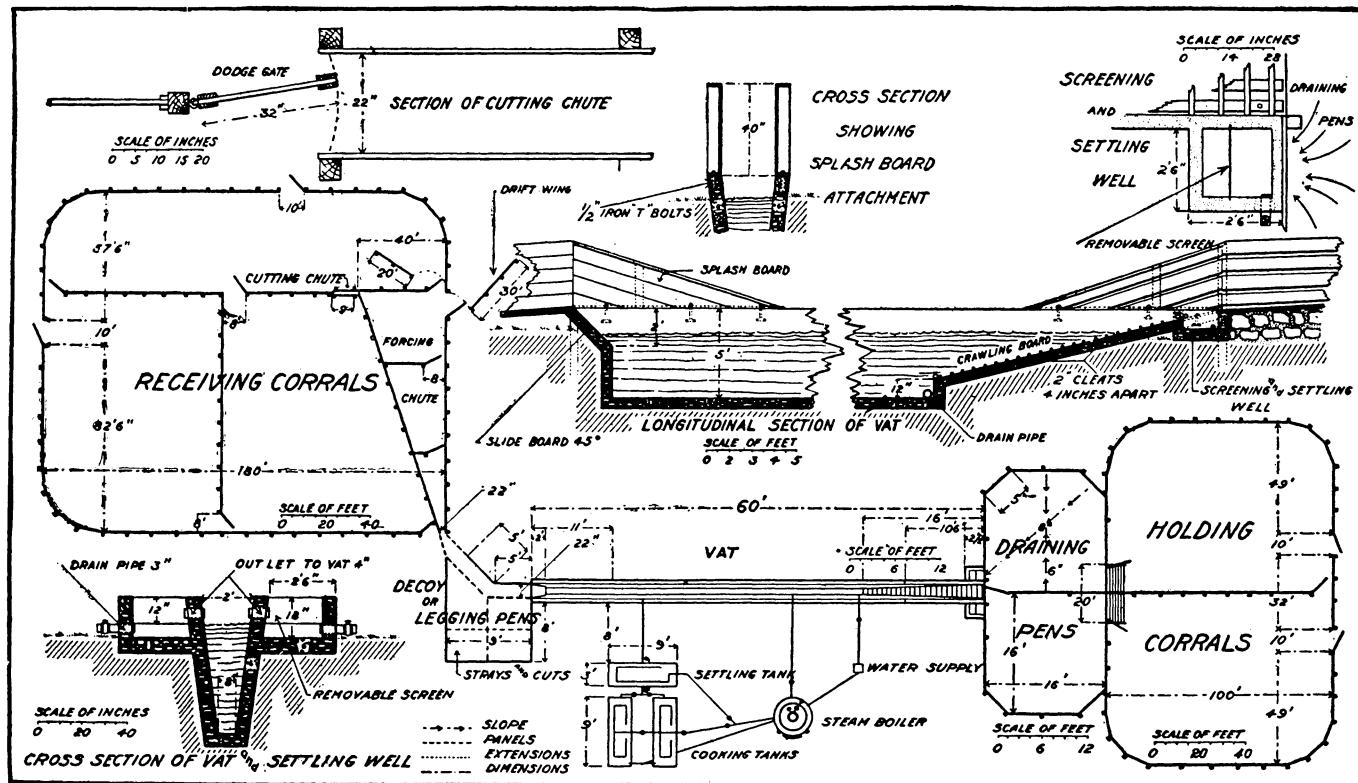


Figure 16.—Plan of sheep-dipping plant; concrete vat.

should each be large enough to hold a full band of sheep, or about 3,000 head. The receiving corral should be constructed with a minimum of corners or other places in which the sheep may become jammed or piled up.

Sheep will try to get out at the place where they entered; hence, if the entrance gate is near the vat the herd will tend to crowd toward the vat and thus save considerable work in getting them into the chute or catch pen. The corrals and chutes may be arranged as a combination catch pen and running chute.

Sheep usually work well in a chute the first time they are dipped, but old ewes that have been dipped several times at the same vat often have to be put into the vat by hand. The location and arrangement of the chutes are sometimes changed from year to year so the sheep may not recognize them so readily.

The running chute should be curved to obstruct the view, and the side on which the men work should be tightly boarded. The usual height for the sides of the chute is 40 inches. The chutes and alleys should slope upward to the vat. If necessary, elevate the running chute so that it will slant upward to the slide board.

A small pen should be provided near the entrance to the vat and should be so arranged that the sheep may see it. This pen, known as a "decoy pen," should be filled with sheep to induce the others to join those in the pen.

### Draining Pens

When a sheep emerges from the vat it carries out a large quantity of dip in its fleece. Most of this dip drains off very rapidly, and should be saved and returned to the vat. Draining pens with water-tight floors sloping toward the vat should therefore be provided. The size will depend on the size of the

plant and the number of sheep to be dipped. The relative size shown (figs. 15 and 16) may be followed, the size of the pens being increased or decreased to correspond to the length of the vat.

There should be two draining pens, each having an opening into the holding corral. They may be made of lumber or concrete, and should have catch basins or screening and settling wells into which the dip will drain. This will prevent manure and foreign matter from being carried into the vat. Drawings of screening and settling wells will be found in the plan of the concrete dipping plant (fig. 16).

In constructing draining pens make the concrete retaining walls 4 inches high and 6 inches thick, and lay them in the same manner as the foundations of a house. Then fill the space inside these walls with gravel to the required height and lay the floor. Concrete floors should have rough surfaces to prevent slipping. A coat of "pebble dash" over the concrete floors will afford a suitable surface for sheep to stand on. The floors of draining pens should slope so that the dip will drain away rapidly and not collect in pools from which the animals may drink.

### Vats

The dipping vat may be either concrete or lumber, although concrete is preferable. The length of the vat may vary from 30 to 100 feet, depending on the number of sheep to be dipped. Public dipping vats, where from 50,000 to 100,000 sheep are dipped each season, should be 100 feet long. The depth should be 5 feet, the width at the bottom 8 inches and at the top 2 feet. Some sheep vats are constructed with the top flush with the ground. However, the top of the vat may extend from 9 to 18 inches above the ground. Those extending above the ground make

it easier to handle the sheep and require less effort in the dipping operation. If the top of the vat is flush with the ground, build it at least 4 inches above the natural surface and then fill in with dirt or gravel to obtain proper drainage along the sides.

There should be no crosspieces to interfere with free action of the sheep or of the men working along the vat.

Whenever possible, arrange to drain the vat by gravity; otherwise each time the vat is cleaned, it will have to be pumped or dipped out. If the end at which the drain is located is slightly lower than the other end, the liquid will drain off.

The slide board into the vat should be set at an angle of  $45^\circ$  and should extend from the floor of the chute to a point at least 4 inches below the dip line. It should be made of, or covered with, a smooth-surfaced material, such as planed lumber or sheet metal. The end extending into the dip should be flush with the vertical end of the vat. No space should be allowed between the slide board and the end of the vat, large enough for a lamb to lodge in.

The runway leading out of the vat should not be too steep. The length should vary from 8 to 16 feet, the latter length being preferable in large vats.

**WOODEN VATS.**—In wooden vats, one side of the running chute is made of portable panels, so that they may be shifted and the space converted into a catch pen. Two styles of framing are shown (fig. 15). In cedar-growing sections of the country, cedar-post frames are preferable because they do not decay rapidly, as do the sawed white-pine timbers. When hardwood is used instead of white pine the frame timbers need not be so heavy; 4 by 4 inches is heavy enough.

The frames are set from  $2\frac{1}{2}$  to 4 feet apart, depending on the character of the soil and the

material used. The closer the frames are to each other the less tendency there will be for the sides of the vat to bulge in between the frames. Two-inch tongued-and-grooved planks should be used in making the vat, and they should be beveled and all joints and seams properly calked with oakum or similar material.

**CONCRETE VATS.**—In the plan for the concrete plant the corrals and chute are conveniently arranged. The portable panels can be shifted to form either a running chute or a catch pen. The settling and screening wells shown can be constructed as a part of any vat by changing the slope of the draining pens so the dip will run into the wells instead of down the runway. In making the forms for a draining well a groove into which the removable screen is set should be provided as well as a 4-inch opening into the vat.

The trench for a concrete vat should be excavated so that the inside trench dimensions will correspond to the outside dimensions of the vat. If the sides of the trench are smooth and reasonably firm they can be used as the outer wall of the form, but in all cases where the vat is extended above the surface of the ground it is necessary to build forms extending from the surface of the ground to the top of the vat. If the soil is sandy it will be necessary to build outer forms, in which case the trench should be wide enough to allow for these forms.

The drain and other pipes shown in figure 16 should be placed in the form and all of them threaded and capped, so that proper connections may be made. Three pairs of  $\frac{1}{2}$ -inch bolts should be embedded in the concrete of the incline, to be used in attaching the false floor or runway. This floor is made of 1- by 6-inch boards laid lengthwise with cross cleats, as shown in drawings. Also two pairs of bolts to be used in

attaching the slide board should be embedded.

Steam pipes should not be molded into the concrete walls, as the vibration of the pipes will crack the cement. They should pass over the top of the vat and down the side in a groove formed in the wall, so they will not come in contact with the sheep or cause annoyance to the men working along the vat.

The walls should be 6 inches thick, constructed of concrete mixed in the proportion of 1 part cement,  $2\frac{1}{2}$  parts sand, and 4 parts broken stone or gravel. Slush this mixture into properly set forms, and when it approaches dryness remove the forms. Coat the inside surface of the vat with pure cement mixed to about the consistency of cream. Apply it with a brush. It is important that this coating be well brushed in so as to fill all cavities and form a smooth surface.

### Heating Facilities

When lime-sulfur dip is used, cooking tanks are necessary. The cooking may be done by steam or in open boilers placed above a fire box. All large plants should have steam boilers of not less than 25 horsepower. The live steam can be piped into the dipping vat to maintain the temperature of the dip, and also into the cooking and heating tanks where they may be used in boiling the dip or heating water. The steam pipes should extend along the floor of the vat at least two-thirds of the length, and should be provided with openings for the escape of steam into the dip.

The supply pipe from the settling tank should enter the vat above the dip line, in order that any leak may easily be detected.

Heating tanks or boilers are necessary, the size depending on the number of sheep to be dipped. An ordinary iron caldron or kettle will answer the purpose for a small number of sheep. A rectangular gal-

vanized-iron tank with a large heating surface is preferable. Such a tank can be set on a concrete foundation about 2 feet high, open at one end. The foundation thus provides a fire box, fed at the open end and having an opening large enough for the escape of the smoke at the opposite end.

### Determining Capacities

The capacity of the vat and the various tanks must be known. The capacity of the vat is usually obtained in the following manner: Multiply the average length by the average width in inches, then the product by the depth in inches; this will give approximately the number of cubic inches of space to be filled with dip. Divide this by 231 (the number of cubic inches in a gallon) and the result will be approximately the number of gallons of dip required to fill the vat.

To obtain the average length, add the length at the bottom to the length at the top (that is, at the line to which the vat is to be filled) and divide this sum by 2. Obtain the average width in the same manner. The depth should be taken at the center of the vat, and should be measured from bottom to dip line. Measure only the space to be filled with liquid, not that above the dip line. Gages or rods should be prepared and marked to show the number of gallons at various depths.

### Care of Plant When Not in Use

A dipping plant that does not receive proper care when not in use deteriorates very rapidly. The pressure of the ground against the sides of the vat tends to cause them to bulge inward; this tendency may be counteracted to some extent by keeping the vat full of liquid. Wooden vats, allowed to stand empty, dry out and the lumber

shrinks, causing the vat to leak when refilled. At the close of dipping operations, leave the vat full of liquid, and add water from time to time to restore that lost by evaporation.

The entire plant should be over-

hauled and put in good condition a week or 10 days before dipping operations are started. Before filling a new vat or one that has stood empty for some time, fill it with water to find out whether it leaks.

U. S. GOVERNMENT PRINTING OFFICE: 1958

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